Steep-Dip Seismic Imaging of the Shallow San Andreas Fault Near Parkfield

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Seismic reflection and refraction images illuminate the San Andreas Fault to a depth of 1 kilometer at the location of the proposed SAFOD drill site. The prestack depth-migrated reflection image contains near-vertical reflections aligned with the active fault trace. The fault is vertical in the upper 0.5 kilometer, then dips about 70° to the southwest to at least 1 kilometer subsurface. This dip reconciles the difference between the computed locations of earthquakes and the surface fault trace. The seismic velocity cross section shows strong lateral variations. Coinciding relatively low velocity (10 to 30%), high electrical conductivity, and low density indicate a 1-kilometer-wide vertical wedge of porous sediment and fractured rock immediately southwest of the active fault trace.

Seismic cross sections across the San Andreas Fault (SAF). Surface locations of the Gold Hill Fault (GHF), Buzzard Canyon Fault (nf), and drill site are indicated. The reference datum is 700 m above mean sea level (MSL). (A) Seismic velocity model derived from first-arrival travel times. Contours every 0.2 km/s are labeled in km/s. Areas without rays are white. The magenta line indicates a sample ray path reflected from a vertical plane beneath the surface trace of the SAF. (B) Prestack depth-migrated reflection image. Red and blue indicate positive and negative peaks of a reflected wavelet. Green arrows indicate interpreted reflections from the SAF and GHF fault planes. Migration artifacts create a circular smile pattern across the image, particularly at the ends of the image. Pre-processing to emphasize steep reflectors eliminated energy from shallowly dipping reflectors.